LECTURE NO. 17

LIGHTING AND ITS RELATION TO THE INDUSTRIES.

Thought on the question of Industrial Lighting reveals the importance of this phase of plant operation. On the other hand, observation of actual installation shows it to be one of the most neglected fields to which light is applied. Stores, for example, are usually well lighted, for a merchant realizes that light attracts the crowd and increases his business. Residences in general, are well lighted, for there one must relax and obtain the comfort which comes with adequate illumination. Offices and commercial interiors of this character, are, on the whole, quite satisfactory, for office managers realize that employes, clerks and stenographers, cannot turn out satisfactory work unless they have suitable lighting.

Leading industrialists who have studied and experimented with good lighting have demonstrated the economic value of high standards, but the rank and file especially of the smaller manufacturers are still ignorant of the large savings which result from relatively small expenditures, for more liberal lighting. Even where proper lighting equipment is available, the slow depreciation and insidious losses from neglect to provide proper maintenance is often overlooked.

It may be safely said that adequate lighting increased production, promotes safety, produces a tidy and clean mill, and makes workers cheerful and contented. These may seem like broad statements but they are borne out by the facts some of which we

will have an opportunity to examine as we proceed with the analysis of the subject. The first phase of this analysis covers the relation of light to production.

Engineers who have investigated the subject have realized for a long time, that good lighting did actually increase output, but definite figures have never been available, until within the last year or so.. The determination of the relation between light and output is evidently tedious and lengthy. Nevertheless, the Commonwealth Edison Company of Chicago, report the completion of a series of tests along this line.

The first of these tests was in a machine shop of one of the large Chicago concerns. This shop was originally lighted with a system of incandescent lamps in steel reflectors carefully arranged to produce an even intensity of 4 foot candles of illumination at the work. The men worked under these conditions for a period, then the intensity was increased to 12 foot candles. In other words the lighting was trebled. This change was attended by a 8 to 27% increase in production. These figures cover eight different operations, and show an average increase of 15%. Every precaution was taken to insure fair results, and the figures are confirmed by the manufacturer's records.

This figure is really remarkable, an average increase of 15% in output as a result of an extremely small actual increase in operating expense. The initial intensity 4 foot candles originally found in this plant is ordinarily considered good lighting. Certainly, tremendous increases are possible in plants which now have only 1 foot candle or even lower illumination on the work.

SLIDE NO. 1

Since this time, the Commonwealth Edison Company have finished four other tests. The results of the second test are shown in the table on the screen. In this particular instance, there was an average of 35% increase in production at the cost of but 5% of the pay roll. No matter how efficient our machinery may be, production depends on the combination of the machine and operator. If we increase the efficiency of the operator a certain amount, the efficiency of the combination will be increased.

SLIDE NO. 2

The results of the third investigation are indicated in the illustration. In this case, the average increase in production was 15%. If the lighting is poor or inadequate, the workman will be less efficient during the hours when good daylight is unavailable. If when the artificial system is turned on, the intensity is low in comparison with daylight, his movements will slow up.

SLIDE NO. 3

He must be more cautious for he has not the confidence which comes with clear vision. He will waste time trying to see his work under poor lighting. If the artificial lighting is of a type which is under his control, that is, drop lamps, considerable time may be spent in adjusting it to suit his whim. In this particular test, there was 10% increase in production at a cost of but 1% of the pay roll. If sources are in the field of view, the workman's eyes are seriously strained, discomfort results and the efficiency is seriously depleted. It is quite obvious that all these items combine to decrease production.

SLIDE NO. 4

Here is a 12% increase in production reported with a total lighting cost of less than 1% of the pay roll affected. Note that the increased cost over poor lighting must necessarily be even less. If a man can save a moment or more of time due to better lighting, he has paid for it. The figures which have been presented on the screen should vividly impress one, that from the standpoint of economics alone, lighting plays a very important part in satisfactory operation.

SLIDE NO. 5

The second phase is the relation between light and safety. There is no doubt that good lighting is one of the most effective agents in promoting safety. Suitable light is as essential to the safety of the employees as any of the safeguards which are applied to belts, pulleys, etc. Thru the Safety First movement, the employee is taught to care for himself and others and the employer has been compelled to make working conditions as safe as possible, In the year 1910, more than 91,000 accidents occured in and about industrial plants and of this number 23.8% were due directly or indirectly to lack of proper illumination; 10% of the total industrial accidents for the year were due primarily to inadequate illumination, and in the remaining 13.8% the lack of proper lighting facilities were in contributing cause. The subject is of such great importance to the plant operator that it is well for him to give the matter careful study in the attempt to eliminate such conditions from

his shop. He should ask himself the question: is there artificial illumination in every part of the plant likely to be traversed by workmen? Are all moving parts clearly visible and are the lights so shielded that a man will not be temporarily blinded and thus not be able to see gears, belts and other mechanisms?

SLIDE NO. 6

A comparison of the day and night accident rates for various years taken from one of the Senate documents shows that the night death rates exceed the day, though processes carried on are inherently less dangerous. This diagram is also given to show the gradual decrease in accident rates due to improvement in safety devices and similar precautions. The Department of Labor in many states, has been empowered by the Legislature to put into effect rulings designed to protect employees. These bodies have recognized that many accidents may be avoided if proper lighting is provided and have prepared codes of lighting which are enforced by departmental inspectors. In the states where such rulings are in effect, it is, of course, essential to comply with them. In other localities, it is to the interest of the plant owner to see that similar conditions prevail.

SLIDE NO. 7

The minor effect of correct lighting has been mentioned before and if a shop such as this is well lighted, it will necessarily be tidy, for litter and refuse will not be permitted to accumulate. Waste material always gathers in the dark corners. Shop sanitation is an important element. A well lighted shop is pleasant to work in. It attracts and holds employees and in view of the possibilities of great labor shortage along certain lines, this feature is of much importance, for contended employees certainly contribute an essential asset.

SLIDE NO. 8

This example as given on the right is quite typical of many industrial plants. Who could work under such conditions and not become quickly fatigued? At the left is the case of a local lamp shaded by a reflector, directing the light on the work and shielding the eyes. Certainly, the elimination of glare makes for more pleasant working conditions. The workman with a local lamp frequently complains of insufficient light when in reality the intensity may be higher than is required for the work. In case an attempt is made to correct this by installing a larger lamp, the workman's eyes are subjected to a still more severe strain. The proper correction is of course, to shield the light by means of a reflector, which also directs more light on the work. In view of these objections, to local lighting, among others which will be mentioned later, it is seldom advisable to install this system except for cases where general illumination is not appropriate.

SLIDE NO. 9

A number of years back, the only system used for industrial lighting was by means of local or drop lamps. Now, however, with efficient MAZDA lamps available, it is entirely practical to supply a sufficiently high intensity of illumination over the entire room and eliminate the inconvenience and inefficiency of these local or drop lights. Of course, there are certain conditions where it is good economy to install local lamps. For example, in the view shown on the screen, where watch parts are being manufactured, the work is so minute in character that the intensity required is extremely high in order that all details may be clearly seen. In such a case, a local lamp properly fitted with a reflector correctly placed is entirely good engineering.

SLIDE NO. 10

Among other objections to local lighting is the great liability of glaring reflection of the lamp filament, from the table of machine which these illuminate. Glare is produced by specular reflection from glared surfaces, desk tops, polished metal, etc., and often produces eye trouble, head aches and other indispositions, although the sufferer may not be aware of the cause. The remedy is to change the relative position; so that the reflected light is kept out of the eyes, as much as possible, and to enlarge the dimensions of the light source or introduce diffusion.

SLIDE NO. 11

Glare is produced by the lamps themselves or by specular reflections. For example, in this metal working plant with a quantity of hot material about on the floor, we have plenty of intensity or enough illumination on the work, but the reflectors do not come quite far enough down to shield the lamp and one is likely to be temporarily blinded by a brilliant light source and stumble over something lying on the floor. It is particularly important to avoid glare under such dangerous conditions.

SLIDE NO. 12

Here we have a shop well illuminated by lamps entirely out of the field of view being hung close to the ceiling located between the trusses, the distribution of illumination is even and there are no objectionable shadows present. A common defect of industrial lighting is improper distribution of illumination. This may be due to too wide a spacing of lighting units and under this condition some parts of the room are insufficiently lighted while others may have

more light than is actually necessary.

SLIDE NO. 13

In the machine shop and places of this character, the direction of light is also an important point to consider. If light comes from the wrong direction, parts of the machine may be in shadow. If bright areas are near the shaded ones, the illumination is rendered less effective by contrast. If a powerful lamp is located improperly in regard to a lathe, shaper or planer, the head of the machine or chucker, may cast a shadow on the working point, which makes the illumination practically useless. It is quite evident that when we have good general illumination, as illustrated in this picture, there is no necessity whatever for local or drop lights.

SLIDE NO. 14

Since the purpose of lighting is to enable the operator to see, good illumination cannot be prescribed until we have some knowledge of the use to which it is to be put. In order to properly plan the lighting of a factory, one should be familiar with the processes employed, the arrangement of machinery and the work tables as well as the quality of products manufactured. Custom has established certain methods of lighting which are entirely satisfactory if properly applied for the different processes of manufacture. We know approximately how much illumination is necessary for the ordinary grade of work, which is performed on the lathe as well as the direction desirable. The codes of lighting prescribed by the Bureau of labor in different states specify certain minimum intensities of different classes of work. These minimum intensities take care merely of the safety requirements and are nowhere near as high as desirable for production results.

Where extensive lighting problems are to be solved, it is advisable to obtain a competent engineer with illumination experience. Lighting of the type now before us, is an excellent example of localized general illumination. Those plants which are today securing poor illumination with inefficient lighting units can now secure good illumination by installing a modern lighting system without great additional cost. In many cases the desired result can be obtained by an actual reduction in operating cost.

Before taking up the question of the application of light, let us briefly examine the illuminants themselves. The MAZDA lamp is in many respects an almost ideal illuminant, for it can be effectively adapted to all classes of lighting. There are no moving parts to get out of order, and skilled attendance is not necessary. All types operate equally well on alternating and direct current and all frequencies with unity power factor. The light produced is steady and is not seriously affected by voltage fluctuation. There is an extremely wide range of sizes available such as is found in no other illuminant, so that exactly the correct amount of light can be produced for all ordinary conditions.

<u>SLIDE NO. 15</u>

Small sizes of MAZDA lamps are made of the vacuum construction and are known as MAZDA "B". In these lamps the filament is wound on flexible anchors in a loop form and the clear glass bulb is carefully evacuated. This construction is used on all the smaller sizes from 10 to 60 watt. Such lamps are used for local lighting or for general illumination where only a very low intensity is required.

SLIDE NO. 16

Where lamps are subject to very rough usage, as for example on drop cords, another style of MAZDA Lamp known as the Mill type has been developed. Note in these, a special construction of filament winding take up the effect of shock and jars. ALL MAZDA Lamps are standardized as well as sockets, holders, reflectors and other accessories. The initial investment for a MAZDA Lamp installation is very low in comparison with other illuminants and due to this very feature, advantage can be taken of future improvement without the loss incidental to the scrapping of expensive equipment which has become obsolete.

SLIDE NO. 17

In the MAZDA C Lamp, the filament is coiled to resemble a very fine spring and this supported by a set of anchors. The bulb is evacuated, and inert gas or mixture of gases is introduced in the bulb. This form of construction has caused such MAZDA Lamps to be occasionally referred to as gas filled or nonvacuum. The action of the gas in the bulb is to retard the evaporation of the filament and permit a higher operating temperature. The higher the temperature of the lamp filament, the greater the amount of light produced for a given power consumption. MAZDA C Lamps are made in sizes from 50 to 1,000 watts and are eapecially well adapted to localize general or general illumination.

SLIDE NO. 18

While MAZDA Lamps are made for 110 to 125 and 220 to 250 volt circuits, it is advisable in planning the layout for lighting to provide 110 volt circuits.

Lamps of the 110 volt type are somewhat more efficient than those of higher voltage and of a much more uniform quality as well as lower cost. Although MAZDA Lamps are not seriously effected by ordinary voltage fluctuation, it is very desirable to separate lighting circuits from power circuits, as the variation in intensity is annoying to persons working in the room. This comparative table shows some of the advantages of the lower voltage lamps.

SLIDE NO. 19

Many people imagine that the bowl frosting or bowl enameling of lamps causes a great decrease in light output. This is not the case as indicated by the data now before us. The Bowl Enameled MAZDA "C" Lamps in RLM Standard Dome reflectors will fill the requirements of over 90% of Industrial Lighting. The efficiency of this unit will be about 92% of that of the same reflector with a clear lamp; but the elimination of glare and the better diffusion and quality of the illumination secured more than make up this decrease in efficiency.

SLIDE NO. 20

Light may be produced by lamps without reflectors, it is true, but this would be wasteful of power and cause ineffective lighting due to glare. The incandescent lamp is designed to be a renewable part and distributes light equally in all directions to meet the universal requirements. A reflector re-directs the light and can be selected to meet particular demands. It directs the light in useful angles. A reflector also protects the eyes of the workmen.

Steel reflectors are generally recognized as standard industrial reflectors, although in certain conditions, glass reflectors may be well suited. In most industries, porcelain enamel is used. It presents a surface which is virtually glass; it can be easily cleaned and its lustre is not destroyed by scrubbing; it is not affected by moisture or acid fumes; after cleaning it returns to practically initial efficiency. The aluminum finish reflector is somewhat cheaper, and many installations are to be seen, in which the reflecting surface has partially peeled off or become so dirty that it is valueless. Any place which has a high humidity has a deteriorating effect on aluminum finish. In most instances, the greater first cost of porcelain enamel is well justified in view of its durability. This particular shape of industrial reflector is known as the deep bowl. It gives what is called a low cut-off, in other words, the lamp is not visible at as great an angle as when used in flatter reflectors. This low-cut-off, however, tends to reduce the amount of light on vertical surfaces and though a room may be excellently lighted on the working plans, it frequently appears dull and cheerless when reflectors are used. The smaller sizes of bowl shaped reflectors are used for local machine lighting, while the larger sizes are applied for localized general or general illumination.

SLIDE NO. 21

The dome type industrial reflector is most widely used; it distributes the light thru a wide angle and if properly designed has a sufficient cut-off to shield the eye.

It is considerably more efficient than the deep bowl type. When the bowl enameled lamps are used in the dome reflector, excellent results are obtained, the room appears bright and pleasant, and vertical surfaces are well illuminated. The dome reflector is so important in industrial lighting that the leading lamp manufacturers have designed and now placed on the market, a dome reflector known as the RLM standard. This name signifies reflector and lamps manufacturers' standard. Typical specimens of these are now on the screen before us. The standardization was necessary due to the fact that when the MAZDA C Lamp first appeared on the market, there was no reflecting devices especially designed for it, and they were installed to reflectors intended for use with MAZDA B Lamps. The following general specifications apply to RLM standard dome reflectors. The material shallbe be porcelain enameled steel; the weight and quality of the material and the workmanship shall be such as shall insure a good serviceable body, withstanding ordinary handling without losing shape, and without cracking of the enamel. The angle of cut-off shallbe 17½ degrees below the horizontal. The diameter of the reflectors for the different sizes of lamps are also specified, and the contour shall be such as to avoid undue concentration of light beneath the unit.

SLIDE NO. 22

An angle reflector is of the deep bowl shape with the holder set as its name implies, at an angle. Such equipment is especially useful where high illumination is required on vertical surfaces. Small sizes of angle reflectors are also made for local machine lighting.

SLIDE NO. 23

There are a number of styles of especially designed equipment for industrial lighting. A typical one is known as the reflecto cap diffuser. A polished metal cap is held under the lower half of the lamp bulb to cut off the direct light of the lamp. The reflecto itself is relatively large and these two features give excellent diffusion eliminating sharp shadows and annoying reflections. This special combination reduces the total output of light somewhat and necessitates a higher first cost. Where especially well diffused illumination is desired such a unit proves very useful. As for example, in machine shops or places of this character, where are likely to be glaring reflections from polished metal surfaces.

SLIDE NO. 24

Other diffusing units consist of opalescent enclosing globes about the lamp with white, relatively flat reflectors placed above these. Some of these are made in two pieces and others in one piece of glass with white enamel applied to the surface of the glass. If these units are well designed, they prove very useful for industrial lighting, producing a cheerful appearance and giving a satisfactory light output as well as good diffusion. These should be so designed to minimize dirt accumulation.

SLIDE NO. 25

It has already been pointed out that the RLM Standard Dome Reflector with a Bowl Enameled Lamp MAZDA C form a most practical unit for Industrial Lighting.

This Bowl Enameling is a special white enamel applied to the exterior of the lamp bowl, and acts as a diffusing and reflecting surface. When the enamel has been "aged" by burning the lamp several hours, it may be washed or even scrubbed without danger of injuring the enamel.

SLIDE NO. 26

Allthe units which have been examined up to now have been of the type known as direct lighting. The larger part of the light is distributed directly from the lighting units to the surface to be illuminated. With some indirect lighting, however, the light source is shaded by a translucent reflector and the larger part of the light thrown upon the ceiling for redistribution. Semiindirect lighting if properly designed, gives excellent diffusion and is often applied to industrial lighting, with good effects where light ceilings are available. The particular type of semi-indirect unit on the screen is very inexpensive, correctly designed and produces excellent results It is of dense glass, so that large lamps may be used in a comparatively smallbowl without the bowl appearing excessively bright and producing glare.

SLIDE NO. 27

With indirect lighting, the light source is entirely concealed and the light thrown on the ceiling and then redistributed for use. This gives very good diffusion to the illumination and very soft lighting. Both semi and totally indirect units are particularly susceptible to the accumulation of dirt and dust, which brings us to an important point in connection with any system of lighting.

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SLIDE NO. 28

The efficiency of any system of illumination is dependent to a large degree upon cleanliness. A large percentage of the light will be absorbed and wasted in the transmitting and reflecting surfaces, if they are allowed to accumulate dust, dirt, grime and oil. Even with direct lighting, the question of cleaning is of much importance, for while the depreciation is not as rapid, it is most certainly present. An example of this can be taken from the reading of the curve now before us. An opaque reflector which is least susceptible to the collection of dirt and dust of any, depreciated over 10% in light output in a 12 week period, while the light density opal glass direct lighting reflector depreciated nearly 25% in the same period. Haphazard cleaning has not been found satisfactory. The accumulation is so gradual that it is not readily noticed by those responsible. Much better success has been secured by organized cleaning at stated intervals in charge of a suitable department.

SLIDE NO. 29

As a result of a campaign of education on the part of certain paint manufacturers, the industries now realize that natural light is greatly aided if walls and ceilings are white in color. Any light striking these parts of the room is reflected in a degree depending on the color. If dark brown or smoke covered, only about 5% will be reflected. If pure white, the reflection may be as high as 70%. If this feature is of importance in the day time, when intensities run far above those ordinarily applied artifically, how much more essential is it at night?

Even the color of the floor affects the resultant illumination for part of the light which strikes it goes back to the ceiling and then down again. It is a real paying investment to keep walls and ceilings light in color. The lower part of the side walls are of less importance in reflecting light and for purposes of appearance, it is often desirable to have a dado of dark green or some neutral color as finger marks and other disfigurements are noticeable. This feature also reduces the brightness in the field of view. The figures now on the screen before us show how much power can be saved by a mere application of paint. Throughout the country thousands of dollars are being wasted annually through improperly painted walls and ceilings.

SLIDE NO. 30

A few years ago, low candle power, inefficient carbon incandescent lamps and high power arc lamps were the only two electric illuminants suitable for industrial lighting. At this period, there were two extremes of practice. Drop lamps were hung close to the work and arc lamps were placed widely and hung as high as possible, Direct lighting was universally applied. Drop lamps were either bare or equipped with painted conical shades which concentrated the light directly beneath the unit. The reflectors on the arc lamps generally were relatively inefficient on account of arc travel. When the efficient MAZDA Lamp appeared on the market, it very soon replaced both the carbon and the arc lamps and as intermediate practice came into vogue, termed localized general or group lighting.

This practice differs from general illumination, in that instead of striving for an even intensity throughout the room, lamps are arranged to give a higher intensity and the correct direction of light at certain points on the machine with a lower intensity at intermediate points. A machine shop lighted by such a system is now before us.

SLIDE NO. 31

This diagram is made up to show what is meant by localized general illumination. It willbe noted that the system is far more general than local. Units are hung relatively high, 9 or 10 feet and are so located that the maximum intensity is directed towards the tools. Here, for example, we have lathes and a bench. The direction of light is correct for the lathes, and units are located with reference to the benches to illuminate shadows which might result if purely general illumination were used.

SLIDE NO. 32

General illumination is secured by uniformly lighting an area irrespective of the location of machinery. The system approaches day light in character and uniformity. General illumination, where feasible, is to be preferred to local lighting. Fewer outlets are required, lessening wiring costs; renewal costs are lower as lamps hanging out of reach are not so likely to be broken; reflecting equipment does not become useless through handling; the room is far more business-like and more cheerful. This diagram is made up to show the methods of supplying general illumination. In the main crane bay, relatively large units are hung above the crane travel with dome reflectors directing the light downward. At each side, below the crane track are located angle reflectors lighting the floor area in the manner

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illustrated. In the side bays, with their comparatively low ceiling two rows of units are used, hung close to the ceiling, evenly distributing the light over the working area.

SLIDE NO. 33

In this particular example of a shop devoted to the manufacture of machine tools, we have allthree methods mentioned on connection with the proceeding slide, shown in actual use. A uniform distribution of illumination is secured of the high intensity required. The assembling is carried on in the central bay where a somewhat lower intensity is suitable.

SLIDE NO. 34

In this carpenter shop the principles of localized general lighting have been applied. 100 watt MAZDA C Lamps with their tips bowl frosted or etched, are used in dome type reflectors 10' above the floor. They are not symmetrically spaced throughout the room, but are located with reference to the individual machines. The carpenter shop with its swiftly moving tools must have good illumination if safety is to be promoted.

SLIDE NO. 35

Up to now, we have been outlining the general principles applied to industrial lighting. We will now have an opportunity of examining several typical installations and analyzing these as to the lighting requirements as well as the methods of treating these. Here is a very vivid example of the effects of wall and ceiling finishes. The walls and ceilings are very light in color and the tables are white as well.

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These white surfaces reflect and diffuse the light to a considerable degree, thus greatly increasing the efficiency of the system.

SLIDE NO. 36

This erecting shop is illuminated by the general lighting system large units 400 Watt MAZDA C Lamps in enameled dome reflectors, and hung well up, 30 to 35; and symmetrically spaced, lighting the entire area uniformly.

SLIDE NO. 37

We have just seen an example of the dome shaped units installed in a high ceiling room. In this cotton weave shed, the hanging height but 13' and the same type of units in a smaller size is used on centers 12 x 12; 100 watt MAZDA C Lamps in R.L.M. Standard Dome Reflectors produce a high intensity of evenly distributed general illumination, which is very satisfactory for the purposes much more efficient from every standpoint than the old style drop lamps.

SLIDE NO. 38

In this punch press room 100 watt MAZDA C Lamps are used in deep bowl enameled steel reflectors on a 10 x 12 ft. spacing. They are hung about 9' above the floor and provide even illumination. The light is reflected from the side walls which are light in color giving the room a much more cheerful appearance than ordinarily obtained from deep bowl reflectors.

SLIDE NO. 39

The previous examples which we have examined have been industria reflectors of the steel type.

Occasionally, opalescent glass is applied and in this instance, a light density opal reflector is used. It directs considerable light downward and also allows a fair proportion to be transmitted upward, providing an element of diffusion and introducing considerable cheer and comfort into the room.

SLIDE NO. 40

Here we see the contrast between good and bad lighting in the same room; the old lighting system still being in place. The absence of glare, the more even distribution of light and the absence of dark shadows should be noted in the modern installation with RLM Standard Dome Reflectors and Bowl Enameled MAZDA C Lamps.

SLIDE NO. 41

Combined general and localized lighting is sometimes desirable, the general illumination being supplied by large units and the more intense localized lighting at particular points by small lamps. The localized lighting may be supplied continuously or temporarily as needed. For example, in lighting automatic machinery a moderate intensity of illumination is sufficient at all times; except when the machine is being set up or adjusted; then a localized light is needed at this particular machine. Here is a night photograph of a sewing room in a flag factory. The general illumination is secured by Bowl Enameled MAZDA C lamps in RLM Standard Dome Reflectors and the illumination at the needle point is secured by low wattage Bowl Frosted Mazda B lamps in a deep bowl reflectors on adjustable arms.

SLIDE NO. 42

Where shadows are likely to be cast it is often very necessary to carefully locate lights relative to pieces of machinery. In this laundry for example; the lighting units were not correctly placed in regard to the mangle, and other pieces of apparatus, overhanging parts would cast bad shadows on the inspection table and prevent careful examination of the work. Considerable experimentation must be done in such a place, to insure the correct location of lamps. This was carried out in the particular instance on the screen and the position of each lamp carefully determined in order to eliminate as far as possible, annoying shadows.

SLIDE NO. 43

It was formerly thought to be absolutely imperative to have a local lamp over each piece of shoe making machinery. Later investigations however, have proven this to be unnecessary. For example, here is a group of machines which are illuminated by the localized general lighting system, 75 watt MAZDA C Lamps, with suitable dome reflectors are hung at considerable distance from the machines and the light is directed at the sewing point. There is sufficient spread of illumination for the adjoining area. This produces a much tidier shop and a much more agreeable place in which to work.

SLIDE NO. 44

If an attempt were made to light such a room as this, which is devoted to the manufacture of ribbons by the general lighting systems, the lighting would prove worthless. The overhanging parts of machinery would cast serious shadows on the work. It is therefore quite

imperative to locate small lamps in such positions that these overhanging parts do not interfere with the light.

SLIDE NO. 44 A

Let us examine the most excellent lighting of this shop. Bowl Enameled MAZDA C Lamps in glass top steel Dome Units are used here. In the glass top unit a small amount of light is diffused to the ceiling and makes a most cheerful room to work in. Here again there is no glare and the light distribution is very uniform; the workman will find the same lighting intensity for his work in any part of the room.

SLIDE NO.45

In many instances, where there are a lot of overhead obstruction semi-indirect lighting is very successfully applied. The multiplicity of reflections from the ceiling in every direction cause the light, as one might say, to work around the corners and get down on the work without these overhanging parts casting shadows.

SLIDE NO. 46

It has been mentioned that in certain instances, diffusion is introduced by the use of enclosing globe, about the lamps with a reflector above them to direct the light downward. An example of such a unit now in use is before us. This warping room in a silk mill requires a high intensity of illumination as the threads are very minute, and the good illumination is necessary in order that they may be clearly seen.

SLIDE NO. 47

If we will recall the data given in one of the earlier slides, a considerable portion of accidents occur outside of the building, and the yard of an industrial plant must certainly not be in darkness.